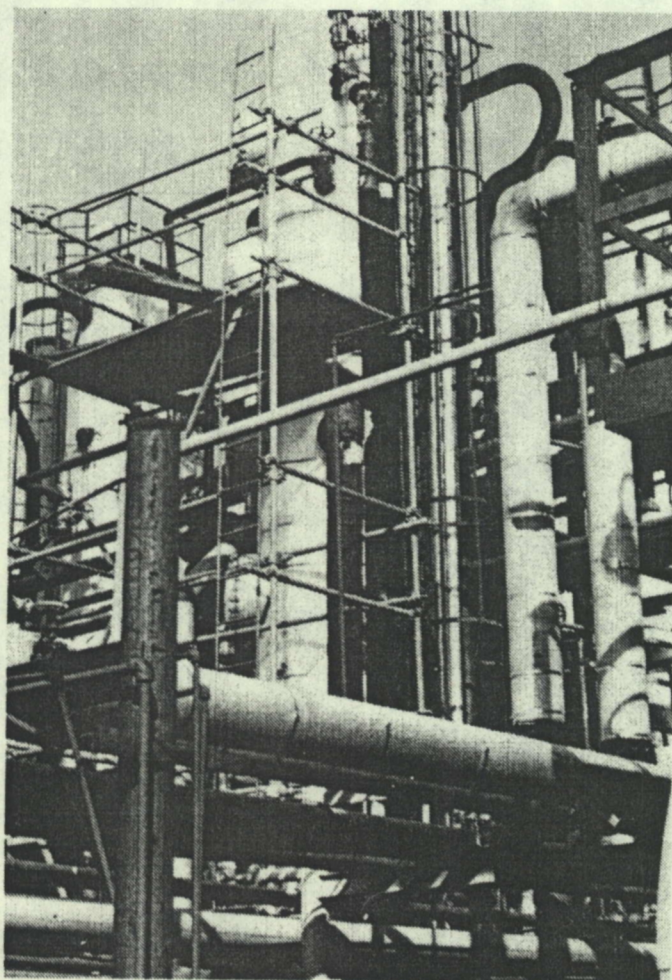


SITE CHARACTERIZATION
and
MITIGATION PLAN
for
PHASE II DEMOLITION
of the
GOLDEN EAGLE REFINERY



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BRIGHT & ASSOCIATES

SITE CHARACTERIZATION AND MITIGATION PLAN
FOR PHASE II DEMOLITION OF THE GOLDEN EAGLE REFINERY

PREPARED FOR
CALIFORNIA DEPARTMENT OF HEALTH SERVICES
AND
LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD

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The South Coast Air Quality Management District (SCAQMD)

The California Department of Industrial Relations
Division of Occupational Safety and Health (CAL-OSHA)

Concurrent with the demolition and restoration approval process GER is proceeding to comply with the RWQCB Order 85-17, which requires oil refining facilities to conduct ground water quality investigations. This Order calls for submittal of a site assessment plan, to be approved by RWQCB, followed by site characterization and remedial measures if necessary.

II. PURPOSE

This site characterization and mitigation plan (Plan) is intended to provide the data needed by the DOHS and the RWQCB to approve the Phase II GER demolition and site (Site) restoration and to comply with the RWQCB Order 85-17.

In preparing this Plan, the actions described in the Environmental Assessment (Bright & Associates, 1985) have been completed as well as several additional geotechnical, water quality and landfill characterization studies, for example: 1) nine additional ground water monitoring wells were developed to determine the ground water gradient and the presence of any pollutants; 2) 21 additional borings were completed to determine hydrocarbon concentrations in the soil; and 3) three new borings were completed in the landfill.

III. METHODS

On-site testing activities included: (1) drilling nine ground water monitoring wells to determine soil characteristics and to analyze samples of groundwater; (2) completing 14 additional soil borings to a depth of 15' and five soil borings to a depth of 60' to determine soil characteristics and hydrocarbon concentrations; (3) drilling three borings to a depth of 60' to determine methane gas and leachate concentrations within the landfill; and (4) monitoring of methane gas at and near the landfill surface. One monitoring well, MW-10, was previously constructed in November, 1984. Two additional soil borings, to a depth of 60', were drilled off-site. Testing locations are shown in Figure 3 and the geologic reports are given in Appendix A.

A. GROUND WATER MONITORING WELLS

1. Locations

Well locations MW-1 through MW-7 were selected to provide monitoring around the perimeter of the Site (see Figure 3).

Results from drilling these wells provided information on the ground water gradient and the determination of the presence of any ground water contaminants. Two additional wells, MW-8 and MW-9, were drilled on the interior portion of the site in locations that have the greatest potential for direct ground water contamination. MW-8 is situated just south of the large tank farm, between the underground storage tank locations, the lead tank location, and the east loading racks. MW-9 is in the process area, next to the small tank farm. The previously drilled MW-10 is near the west loading racks and also serves as a perimeter monitoring well.

2. Drilling Procedures

Monitoring wells were drilled with a 10" hollow stem continuous flight auger, to 20' below the point where ground water was first encountered. Materials encountered in the boreholes were logged, and any odors or visual contamination were noted (see Appendix A). The auger segments were steam cleaned before each borehole was drilled.

3. Soil Sampling and Testing Procedures

Soil samples were taken at 1', 5', and at 5' intervals thereafter, until ground water was encountered. Samples were obtained by driving a standard penetration split-spoon sampler 1' into the soils. Recovered samples were sealed in clean glass jars, logged on chain of custody forms (see Appendix B), and placed in an ice chest. Between each sample the drive sampler was disassembled and decontaminated by removing excess soil, washing in a detergent solution, and rinsing with water. At the completion of each borehole, the samples were placed in an on-site refrigerator.

Analysis for petroleum hydrocarbons by the infrared spectroscopic method (IR) was performed on samples from each well at the following depths: 5', 10', 15', 25', 40', and 60' or 65', depending on where ground water was encountered. All analyses were performed by DOHS certified laboratories. Remaining samples were preserved by refrigeration.

4. Well Construction

After completing the drilling, 4" Schedule 40 PVC well casing was installed through the augers. The lower 25' of casing was perforated with .020" X 2" slots at 180 slots per foot. After installation of the casing, the augers were removed and Lapis No. 3 Monterey sand was placed in the annulus of the well. A 1' thick bentonite seal was placed over the sand pack, followed by back-filling with boring materials to about 10' from the surface. The upper 10' of the annulus was filled with a 7-sack sand/cement slurry (see Appendix A for well construction diagrams).

The wells were developed by bailing approximately 30 to 100 gallons of water from each well. The bailed water was stored in

Where present, samples of landfill leachate were collected, logged on chain of custody forms, refrigerated and analyzed for the same constituents as for the monitoring wells, including extractable organics.

D. SURFACE MONITORING OF METHANE

Monitoring for methane gas was accomplished by placing a grid of 15 gas probes in the fill material on the landfill surface on August 5, 1985 (see Figure 3). The probes, made of 0.5" diameter PVC pipe 2' in length, were placed in 1' deep holes which were drilled with a 4" hand auger. After pipe placement, the holes were backfilled and the exposed ends of the pipes were capped. The gas probes were allowed to stabilize for 1 hour, and then were monitored with a combustible gas indicator, a J-W Sniffer®, Model G. The probes were monitored again 72 hours later on August 8, 1985.

IV. RESULTS

A. WATER ANALYSIS

1. Water Quality

The results of the water quality testing are given in Table 1 (see appendix C for individual laboratory reports), and are divided into the four categories of testing, i.e., metals, petroleum hydrocarbons, purgeable (volatile) organic pollutants, and extractable organic pollutants.

a. Metals

The samples from the monitoring wells and the landfill leachate had undetectable levels of most heavy metals. Trace amounts of chromium, lead, nickel, zinc, antimony, and arsenic were found in some samples. The maximum measurable concentration of any metal in the monitoring wells is 0.011 parts per million (ppm) of nickel in MW-2, and the maximum concentration in the landfill leachate is 0.03 ppm of zinc.

b. Hydrocarbons

Most of the samples had undetectable levels of total petroleum hydrocarbons. Samples MW-2, MW-3, MW-8, and LF-3 had hydrocarbon concentrations of 2-11 ppm.

c. Purgeable Organic Priority Pollutants

Only wells MW-1, MW-2, and MW-8, and the landfill leachate have detectable levels of purgeable priority pollutants.

MW-1 has a methylene chloride concentration of 5 parts per billion (ppb). MW-2 has measurable levels of several priority

TABLE 1
CONCENTRATIONS OF POLLUTANTS
IN WATER SAMPLES

POLLUTANT	WELL NUMBER										
	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	LF-3
Metals (mg/l or ppm)											
Beryllium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-	<0.03
Cadmium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.03
Chromium	0.0016	<0.0005	<0.0005	0.0015	0.0005	0.0071	<0.0005	<0.0005	0.0054	<0.0008	0.024
Copper	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	-	<0.09
Lead	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.004	0.012
Nickel	<0.003	0.011	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.12
Silver	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05
Thallium	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	<0.0016
Zinc	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021	<0.011	0.03
Antimony	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	-	0.007
Arsenic	<0.003	0.0038	<0.003	<0.003	<0.003	<0.003	<0.003	0.008	<0.003	<0.003	0.0038
Selenium	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.005	<0.012
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001
Hydrocarbons (mg/l or ppm)											
	<1	11	<1	<1	<1	<1	<1	3	<1	<1	3
Purgeable Priority Pollutants (ug/l or ppb)											
Acrolein	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acrylonitrile	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzene	<1	53	<1	<1	<1	<1	<1	240	<1	<1	<1
Chlorobenzene	<1	3	<1	<1	<1	<1	<1	<1	<1	<1	1
trans-1,2-Di- chloroethene	<1	26	<1	<1	<1	<1	<1	13	<1	<1	<1
1,2-Dichloro- ethane	<1	<1	<1	<1	<1	<1	<1	18	<1	<1	<1
1,2-Dichloro- propane	<1	3	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	<1	13	<1	<1	<1	<1	<1	<1	<1	<1	2
Methylene chloride	5	<1	<1	<1	<1	<1	<1	3	<1	<1	<1
Toluene	<1	15	<1	<1	<1	<1	<1	<1	<1	<1	3
Trichloro- ethene (TCE)	<1	12	<1	<1	<1	<1	<1	4	<1	<1	<1
Vinyl chloride	<1	20	<1	<1	<1	<1	<1	<1	<1	<1	<1
All others	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

TABLE 1 (continued)

CONCENTRATIONS OF POLLUTANTS
IN WATER SAMPLES

POLLUTANT	WELL NUMBER										
	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	LF-3
Purgeable Non-priority Pollutants (ug/l or ppb)											
Dichlorofluoro- methane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dimethylbutane	<10	80	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyclopentane	<10	<10	<10	<10	<10	<10	<10	400	<10	<10	<10
Cyclohexane	<10	<10	<10	<10	<10	<10	<10	200	<10	<10	<10
Isobutane	<10	900	<10	<10	<10	<10	<10	400	<10	<10	<10
Isopentane	<10	800	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylcyclopentane	<10	200	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylcyclohexane	<10	<10	<10	<10	<10	<10	<10	30	<10	<10	<10
Methyl ethyl ketone	60	<10	<10	<10	<10	<10	<10	<10	<10	<10	30
Terpene	<10	100	<10	<10	<10	<10	<10	<10	<10	<10	10
Tetrahydrofuran	100	<10	<10	<10	<10	10	<10	<10	<10	<10	10
Xylene isomers	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C5 unsaturated hydrocarbon	<10	200	<10	<10	<10	<10	<10	800	<10	<10	<10
C6 unsaturated hydrocarbon	<10	<10	<10	<10	<10	<10	<10	200	<10	<10	<10
Base/Neutral & Acid Extractable Priority Pollutants (ug/l or ppb)											
4-Chloro-3-methylphenol	<1	21	-	-	-	-	<1	-	-	<10	<10
1,2-Dichlorobenzene	<1	2	-	-	-	-	<1	-	-	<10	<10
Diethylphthalate	<1	12	-	-	-	-	<1	-	-	<10	<10
2,4-Dinitrophenol	<1	<1	-	-	-	-	<1	-	-	<25	<25
2-Methyl-4,6-dinitrophenol	<1	<1	-	-	-	-	<1	-	-	<50	<50
4-Nitrophenol	<1	<1	-	-	-	-	<1	-	-	<25	<25
Benzidine	<1	<1	-	-	-	-	<1	-	-	<40	<40
Dibutylphthalate	<1	<1	-	-	-	-	<1	-	-	<50	<50
Dimethylphthalate	<1	<1	-	-	-	-	<1	-	-	<25	<25
N-Nitrosodi-n-propylamine	<1	<1	-	-	-	-	<1	-	-	<40	<40
N-Nitrosodimethylamine	<1	<1	-	-	-	-	<1	-	-	<80	<80
All others	<1	<1	-	-	-	-	<1	-	-	<10	<10

TABLE 1 (continued)
CONCENTRATIONS OF POLLUTANTS
IN WATER SAMPLES

	<u>WELL NUMBER</u>										
<u>POLLUTANT</u>	<u>MW-1</u>	<u>MW-2</u>	<u>MW-3</u>	<u>MW-4</u>	<u>MW-5</u>	<u>MW-6</u>	<u>MW-7</u>	<u>MW-8</u>	<u>MW-9</u>	<u>MW-10</u>	<u>LF-3</u>
Extractable Non-priority Pollutants											
Pentachloro-phenol	<1	<1	-	-	-	-	<1	-	-	<10	<10
C10 Ketone	<1	<1	-	-	-	-	<1	-	-	<10	100
C10 Alcohol	<1	<1	-	-	-	-	<1	-	-	<10	40
C8 to C30 Hydrocarbons	<1	2,000	-	-	-	-	<1	-	-	<10	3,000
Unidentified compound	<1	<1	-	-	-	-	<1	-	-	<10	40

pollutants, including benzene, chlorobenzene, trans-1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, methylene chloride, toluene, trichloroethene (TCE) and vinyl chloride. MW-8 has measurable concentrations of benzene, trans-1,2-dichloroethene, 1,2-dichloroethane, methylene chloride, and trichloroethene (TCE). However, the highest concentration of any pollutant in MW-2 and MW-8 is 240 ppb for benzene (in MW-8). The landfill leachate sample had a chlorobenzene level of 1 ppb, an ethylbenzene concentration of 2 ppb, and a toluene concentration of 3 ppb.

d. Purgeable Organic Non-priority Pollutants

The results of the purgeable pollutant analyses indicate that wells MW-3, MW-4, MW-5, MW-9 and MW-10 have no measurable non-priority pollutants. MW-2 and MW-8 contain concentrations of various petroleum hydrocarbons at less than 1 ppm. Terpene and xylene isomers are present in MW-2 and LF-3, and tetrahydrofuran was present in several samples. All of these compounds, however, are at concentrations of 100 ppb or less. MW-1 also has low levels of dichlorofluoromethane (10 ppb) and methyl ethyl ketone (60 ppb).

e. Extractable Organic Priority Pollutants

This analysis was done for the landfill leachate sample and wells MW-1, MW-2 and MW-7, near the landfill. MW-1, MW-7 and the leachate have no detectable levels of these pollutants. Three pollutants, 4-chloro-3-methylphenol, 1,2-dichlorobenzene, and diethylphthalate, are present in MW-2 at concentrations of 21 ppb or less.

f. Extractable Organic Non-priority Pollutants

The only extractable non-priority pollutants in the monitoring wells are 2 ppm of C₈ to C₃₀ hydrocarbons in MW-2 and 11 ppb of pentachlorophenol in MW-10. The landfill leachate contained 3 ppm of the C₈-C₃₀ hydrocarbon complex and even lower concentrations of an alcohol, a ketone and an unidentified compound.

2. Ground Water Gradient

The ground water levels in each well and the corresponding contours are shown in Figure 4. The contours indicate that the water is mounded in the northeast portion of the property and then flows both to the south and north. The predominate gradient for most of the Site however, is to the south and southwest.

B. SOIL ANALYSIS

Soil at the Site generally ranges from silty sand to silty clay, with isolated occurrences of sand or gravel layers (see Appendix A for boring logs).

The hydrocarbon concentrations in the soil boring and monitoring well samples are given in Table 2. The average hydrocarbon

TABLE 2

HYDROCARBON CONCENTRATIONS IN PARTS PER MILLION (PPM) IN SOIL FROM BORINGS AND MONITORING WELLS

SAMPLE LOCATION	SAMPLE DEPTH						
	5 FEET	10 FEET	15 FEET	25 FEET	40 FEET	60 FEET	65 FEET
SB-1	<10	<10	<10	-	-	-	-
SB-2	16	20	16	-	-	-	-
SB-3	14	28	20	-	-	-	-
SB-4	26	22	14	-	-	-	-
SB-5	1,800	1,700	6,300	-	-	-	-
SB-6	20	83	58	-	-	-	-
SB-7	93	7,700	8,000	-	-	-	-
SB-8	20	32	16	-	-	-	-
SB-9	<10	<10	<10	-	-	-	-
SB-10	11	<10	<10	-	-	-	-
SB-11	<10	<10	<10	-	-	-	-
SB-12	16	<10	<10	-	-	-	-
SB-13	36	<10	<10	-	-	-	-
SB-14	3,600	<10	<10	-	120	62	-
SB-15	6	28	48	98	4	17	-
SB-16	23	970	56	<0.1	6	<0.1	-
SB-17	<0.1	<0.1	<0.1	<0.1	10*	6	-
SB-18	23	51	29	130	97	76**	-
SB-19	19	37	40	160	150	120	-
SB-20	34	35	160	35	35	110	-
SB-21	115	36	178	61	110	-	<10
MW-1	<10	<10	<10	<10	<10	<10	-
MW-2	410	290	21	270	<10	<10	-
MW-3	110	160	23	13	<10	-	13
MW-4	34	<10	<10	<10	<10	-	13
MW-5	4,100	4,200	15,000	<10	4,500	33	4,200
MW-6	2,200	<10	41	<10	<10	-	<10
MW-7	520	7,600	13,000	<10	<10	13	-
MW-8	220	11	760	80	22	-	18
MW-9	330	72	<10	<10	<10	-	<10

*Sample taken at 45'

**Sample taken at 55'

NOTE: MW-5 sample taken at 70' = 57 ppm.

concentration in soils from the off-site borings, SB-20 and SB-21, is 178 ppm, which can be considered the general background concentration for subsurface soils in the vicinity. Six of the 30 borings/wells had hydrocarbon levels exceeding this average at 15' or lower depths: SB-5 and SB-7 had 6300 ppm and 8000 ppm respectively at 15'; MW-2 had 270 ppm at 25'; MW-5 had concentrations of 15,000 ppm at 15', 4500 ppm at 40' and 4200 ppm at 65'; MW-7 had a concentration of 13,000 ppm at 15'; and MW-8 had a hydrocarbon level of 760 ppm at 15'. Most other boring samples had concentrations lower than background, and all other samples from depths greater than 10' had concentrations lower than 178 ppm.

The landfill soil hydrocarbon analysis results are given in Table 3. The only detectable hydrocarbon concentration was 40 ppm at a depth of 3' in LF-1.

C. LANDFILL GAS ANALYSIS

1. Borings

Explosimeter readings of explosive gas, i.e., methane, were taken during and at completion of the landfill borings. Table 4 gives the highest reading at each boring compared with the readings taken at the nearest boring in the previous study (LeRoy Crandall and Associates, 1975). All three of the borings had readings over 100, with a reading of 60 indicating a potentially explosive mixture. The geotechnical report (Appendix A) cites several factors, e.g., subsidence and presence of water, which suggest that methane generation in the southern portion of the landfill has occurred more rapidly than in the north and, in turn, the rate in the southern end could be expected to decrease sooner than in the northern portion.

2. Gas Probes

The results of the gas probe monitoring are given in Table 5. One hour after installation, 9 of the 15 probes had accumulated detectable levels of combustible gas. Two of these, GP-4 and GP-15, had explosive concentrations, and the others had gas levels of 20% - 90% of the amount required for an explosive concentration. The levels after 72 hours were comparable to, but slightly lower than the 1 hour readings. Two of the probes still had explosive levels of gas.

V. DISCUSSION

A. GROUND WATER

1. Water Quality

Generally, the testing results show little pollution of ground water at the Golden Eagle Refinery. Most of the contaminants are

TABLE 3

HYDROCARBON CONCENTRATIONS IN PARTS PER
MILLION (PPM) IN SOIL FROM LANDFILL BORINGS

<u>SAMPLE LOCATION</u>	<u>SAMPLE DEPTH IN FEET</u>							
	<u>2.5</u>	<u>30.5</u>	<u>38.5</u>	<u>39.5</u>	<u>44.5</u>	<u>49.5</u>	<u>50.5</u>	<u>59.5</u>
LF-1	40	<10	-	<10	-	<10	-	<10
LF-2	<10	-	<10	-	-	<10	-	<10
LF-3	-	-	-	-	<10	-	<10	<10

TABLE 4
COMPARISON OF LANDFILL GAS
READINGS TAKEN IN 1985 AND 1975

<u>Boring Number</u>	<u>MAXIMUM EXPLOSIMETER READINGS*</u>	
	<u>1985</u>	<u>1975**</u>
LF-1	30,100	100
LF-2	100	100
LF-3	100	100

*A reading of 60 indicates a
potentially explosive mixture.
**Based on nearest boring.

TABLE 5
LEVELS OF COMBUSTIBLE GAS IN LANDFILL PROBES
ONE HOUR AND SEVENTY-TWO HOURS AFTER INSTALLATION*

<u>Gas Probe Number</u>	<u>Percent of Combustible Concentration**</u>	
	<u>1 Hour</u>	<u>72 Hours</u>
GP-1	0	0
GP-2	0	0
GP-3	40	30
GP-4	100+	100+
GP-5	45	20
GP-6	0	0
GP-7	0	0
GP-8	90	75
GP-9	20	0
GP-10	20	10
GP-11	0	0
GP-12	70	65
GP-13	30	20
GP-14	0	0
GP-15	100+	100+

*Probes put in place on August 5, 1985;
first measurements taken after all fifteen probes in place;
second measurements taken on August 8, 1985, about 72 hours later.

**Percentage of the gas concentration required for
a combustible mixture (100 = combustible).

at concentrations within EPA Maximum Contaminant Levels, EPA National Ambient Water Quality Criteria, or DOHS Action Level Standards for drinking water. However, these standards are considered in this discussion only as reference points, and should not be directly applied to the water in the unused semi-perched aquifer.

There are isolated occurrences of hydrocarbons, including purgeable and extractable organic priority pollutants, in the ground water, but these are at relatively low levels for a semi-perched aquifer, especially considering the history of the general area, i.e., industrial and waste disposal uses. Further, the semi-perched aquifer is separated from the underlying Gage Aquifer by a clay/silty clay layer (BCL Associates, 1985), and this Gage Aquifer is separated from the underlying, usable Lynwood Aquifer by an aquiclude approximately 70' thick (see Figure 5).

a. Metals

The concentrations of metals found in the water samples are all within EPA Maximum Contaminant Levels or National Ambient Water Quality Criteria levels.

b. Hydrocarbons

Most of the samples had undetectable levels of total hydrocarbons. Samples MW-2, MW-3, MW-8, and LF-3 had hydrocarbon concentrations ranging from 2 parts per million (ppm) to 11 ppm, well below the standard of 100 ppm which has been used by the RWQCB in evaluating other refinery cleanup situations. The significance of these levels can be further determined by examining the results of the purgeable and extractable organic compound analyses.

c. Purgeable Organic Priority Pollutants

The concentrations of all purgeable priority pollutants in MW-1 and the landfill leachate and most of these pollutants in MW-2 and MW-8 are well within EPA National Ambient Water Quality Criteria and/or DOHS Action Level Standards for drinking water. There are four contaminants in wells MW-2 and MW-8 which exceed the DOHS standards for drinking water. However, the highest contaminant concentration, 240 ppb of benzene, is well under the RWQCB internal standard for refinery cleanups of 2,000 ppb, and the other contaminant levels do not greatly exceed the DOHS Action Level Standards for drinking water. Table 6 compares these levels with the existing standards.

The semi-perched aquifer is not utilized, and therefore, drinking water standards should not be applied, but used only as a reference point. No direct applicable standards exist.

d. Purgeable Organic Non-priority Pollutants

The analyses of purgeable non-priority pollutants show that wells MW-2 and MW-8 contain various volatile petroleum hydrocarbons at very low concentrations, i.e., a maximum of 0.9 ppm compared with the RWQCB internal standard of 100 ppm. The tetrahydrofuran concentrations range to 0.1 ppm, compared to the EPA Ambient Water Quality Criteria standard of 8.1 ppm. The terpene (natural plant oil) and other compounds, for which no standards exist, also are present at comparable low levels.

e. Extractable Organic Priority Pollutants

The concentrations of extractable priority pollutants found in MW-2 are all below EPA National Ambient Water Quality Criteria or DOHS Action Level Standards for drinking water.

f. Extractable Organic Non-priority Pollutants

These analyses show the heavier petroleum hydrocarbons in MW-2 and the landfill leachate. The concentrations also are well below the RWQCB internal standard of 100 ppm for the cleanup of ground water at oil refineries. There are no standards for the ketone and alcohol in the landfill leachate, but these concentrations are 100 ppb or less and can be considered insignificant when compared to other related compounds for which standards exist.

2. Ground Water Gradient

Considering the largely south to southwest flow of the semi-perched aquifer, wells MW-3, MW-4, MW-5 and MW-10 are the down-gradient wells with respect to the former refinery operations, specifically: the oil farm area; the small tank farm; the process area; the former underground storage tanks; most of the landfill; and the southern portion of the large tank farm. These wells also are down-gradient from the areas with the highest levels of contaminants, i.e., MW-2, MW-8 and LF-3. MW-7 is down-gradient from the northern portions of the tank farm and landfill.

Priority pollutants were undetected in the down-gradient wells. Detected contaminants were: 2 ppm of petroleum hydrocarbons in MW-3; traces of chromium in MW-4 and MW-5; 11 ppb of pentachlorophenol in MW-10; and 100 ppb of tetrahydrofuran in MW-7. These low gradient pollutants are sufficiently isolated and/or diluted to be considered not problematic.

B. SOIL

The soil borings SB-5 and SB-7 are at the former locations of the underground waste oil and gasoline storage tanks respectively, and samples from these borings have relatively high hydrocarbon concentrations at the 15' level. The waste oil tank in particular

TABLE 6

CONCENTRATIONS OF PURGEABLE PRIORITY POLLUTANTS
 COMPARED WITH DOHS RECOMMENDED ACTION LEVELS
 FOR DRINKING WATER* AND RWQCB INTERNAL STANDARD

<u>Compound</u>	<u>Concentration (ppb)</u>			
	<u>MW-2</u>	<u>MW-8</u>	<u>DOHS Action Level</u>	<u>RWQCB Internal Std.</u>
Benzene	53	240	.7	2,000
trans-1,2,-Di- chloroethene	26	13	10	-
1,2-Dichloro- ethane	<1	18	1	-
Trichloroethene	12	4	5	-
Vinyl chloride	12	<1	2	-

*Drinking water standards are given as reference points only and should not be directly applied to the semi-perched aquifer.

1. Landfilling

Disposal in a Class I landfill has been the traditional means of dealing with hazardous material in California. However, this has resulted in environmental problems, i.e., ground water pollution, and difficulties with the siting of new landfills. Consequently, state and federal agencies such as the DOHS and the EPA are developing policies and regulations which discourage landfilling and encourage the development of alternative means of disposal/treatment.

Excavation of soil with low levels of hydrocarbons from the GER site and disposal at a Class I landfill is inappropriate, and it would occupy the limited landfill space available for the disposal of more hazardous materials. A more practical approach is on-site treatment of contaminated soil.

2. Incineration

Although the principles of contaminated soil incineration are proven, there is no practical application of this technology available in California, due to high costs and air emission regulations.

3. Bioaugmentation

Bioaugmentation consists of the introduction of specific bacterial formulations of naturally occurring bacterial species which carry out biodegradation of the petroleum components. The end products of this process are simply metabolic products such as carbon dioxide and water. Bioaugmentation has been used successfully in a number of similar situations, such as, open field oil sumps in Ventura and Ventura, Santa Maria; reduction of heavy, tarry crude oil to a low viscosity, pumpable crude of marketable value, and so forth. Appendix D contains a list of petroleum companies currently using bioaugmentation and reports on the past use of the process.

This practical process will reduce soil hydrocarbon concentrations to acceptable levels without extensive soil excavation, transportation and landfilling, and is the best method of treatment for the Golden Eagle Refinery.

VI. CONCLUSIONS

Based on the information in the Environmental Assessment and in this document, several conclusions can be drawn:

- A. There are no hydrocarbon pools in/on the ground water at the Golden Eagle Site;
- B. Ground water contamination at levels above drinking water standards is limited to a few compounds in wells MW-2 and MW-8. These are acceptable levels for the unused semi-perched aquifer, especially considering that the refinery

operations have ceased and potential sources of contamination have been or will be removed;

- C. With the possible exception of the former waste oil tank location, soil hydrocarbons are not affecting (entering) the ground water;
- D. High subsurface soil hydrocarbon concentrations are limited to a few discrete locations;
- E. The oil farming and tank farm areas have insignificant hydrocarbon levels in subsurface soils;
- F. The hydrocarbon concentration of 3600 ppm at 5' of depth in SB-14 is not deemed significant based on the hydrocarbon concentration of <10 ppm in the soil immediately below, and because there is no migration to the down-gradient well; no mitigation for this area is deemed essential;
- G. Soil samples from MW-2 have hydrocarbon concentrations of 270 to 410 ppm between the depths of 5' and 25'; however, the concentration from 40' to 60' is <10 ppm; this is similar to SB-14 described above and no mitigation for this area is deemed essential;
- H. Soil samples from MW-5 have hydrocarbon concentrations of 4,100 to 15,000 ppm between the depths of 5' and 65'; however, the concentrations at 60' and 70' were 33-57 ppm; SB-15, located 80' to the northeast, had hydrocarbon concentrations of 6-120 ppm; SB-21, located 80' to the southeast had hydrocarbon concentrations of 35-178 ppm; and the ground water sample from MW-5 had a hydrocarbon concentration of <1 ppm; therefore, the soil values for MW-5 are deemed to be isolated and noncontributory to the very low ground water hydrocarbon concentrations, and thus no mitigation action is deemed necessary for the area within and immediately adjacent to this well;
- I. Soil samples from MW-6 have concentrations of 2,200 ppm at a depth of 5' and 41 ppm or less at depths from 10' to 65'; this also is an isolated concentration with no apparent effect on the ground water and no mitigation is necessary;
- J. Soil samples from MW-7 have hydrocarbon concentrations of 520 to 13,000 ppm between the depths of 5' and 15', with 13 ppm or less at depths from 25' to 60'; as for MW-5, this is a small and isolated situation which is not contributory to the very low ground water concentrations of hydrocarbons; this is similar to the situation at MW-5 and MW-6 and no mitigation action is deemed necessary;
- K. Soil samples from MW-8 have hydrocarbon concentrations of <10 to 760 ppm down to a depth of 15'; this situation is

almost identical to that for MW-5, MW-6, and MW-7 and no mitigation action is deemed necessary;

- L. Cleanup/restoration action should occur in all areas where visible petroleum materials occur at the surface (down to + 6" below the surface), and in subsurface areas where the hydrocarbon concentration is greater than 178 ppm, except as noted in F, G, H, I, J and K above;
- M. The landfill is generating significant, albeit small, quantities of methane gas;
- N. Removal of all manmade structures should be accomplished so the adjacent soil area is left as undisturbed as possible, e.g., cement pits, underground piping, etc.; further, removal of such structures, e.g., underground pipes, should be done so any liquids left therein will be removed via a vacuum trunk prior to removal of the structure;
- O. Restoration of the site should be accomplished on-site to the maximum degree feasible as opposed to removal of soil and disposal of same at an approved disposal site; and
- P. The Environmental Assessment and this study adequately characterize the Site; further study to investigate the limited contamination at the GER site is unnecessary.

VII. SITE MITIGATIONS

Mitigation measures required to restore the site for development of an industrial park or other suitable land use are listed below. They are divided into three types of actions: removal of subsurface structures/equipment; treatment of contaminated soil; and mitigations for development on or near the landfill.

A. REMOVAL OF SUBSURFACE STRUCTURES/EQUIPMENT

Asphalt paving and concrete structures, foundations, and paving will be crushed/ground and stockpiled on-site for use as bed material for future roads or other on-site paving.

Pipelines have been emptied and washed in preparation for Phase I demolition. However, there may be some small amounts of residual oil or oily water in the few remaining pipelines. These liquids will be removed with a vacuum truck and recycled or taken to a Class I landfill. Then pipelines will be removed and disposed of.

The removal of subsurface structures/equipment will be done by a licensed demolition contractor in accordance with the below listed SCAQMD rules and per demolition permits issued by the City of Carson.

Rule 402 - nuisance emissions of dust, hydrocarbons, etc.

Rule 403 - fugitive dust

Rule 1150 - excavation permits

B. TREATMENT OF CONTAMINATED SOIL

Based on the information in the Environmental Assessment and this report, as summarized in the above conclusions, only certain surface and subsurface areas require treatment to reduce the hydrocarbon concentrations to an acceptable level. The areas and the related cubic yards per area are listed in Table 7 and Figure 6. A total of 23,681 cubic yards of soil will require on-site treatment.

The process of bioaugmentation to be used for on-site treatment is not complex. The major steps are: formulation of the bacterial species-mix which will be the most effective for the GER site; using a disc to break up the hard, continuous oily surface areas; adding nitrogen and phosphorous to the area to be treated; mixing the bacterial formulations as a slurry; adding the slurry to the area to be treated; and flooding with water the area to be treated. Depending upon the concentration and type of petroleum materials present, one, two, or three applications may be required; consequently, the timeframe may be one to six months until the concentrations of petroleum materials are sufficiently reduced. We plan to use the Advanced Bio Cultures Formulations sold by SOLMAR Corp., Orange, CA. SOLMAR also will serve as a consultant to ensure that the best possible formulation is used, i.e., the formulation best for the conditions at the GER site.

The plan for treatment primarily is based on using the existing diking around the tank farm. Very limited spreading of contaminated soil will be required so that the existing dikes can be used as the treatment area. There are similar areas, where dikes exist or they can be easily constructed by minor movement of on-site soil. Table 7 and Figure 6 show four such areas where treatment in place will occur. There are 10 other areas on the GER site where treatment will be required (see Table 7 and Figure 6). Soil from these areas will be collected and moved to one of the treatment-in-place areas, and then treated. Movement of this soil will be accomplished using caterpillar dozers and dump trucks. The soil will be watered during handling to minimize any TSP emissions.

After the treatment process, there will be no hazardous residue requiring disposal, and there will be no significant impacts to the ground water quality. The bioaugmentation process is proven technology which has been successfully used in many varying hazardous waste situations across the United States.